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(54) PHOTOMAGNETIC RECORDING MEDIUM
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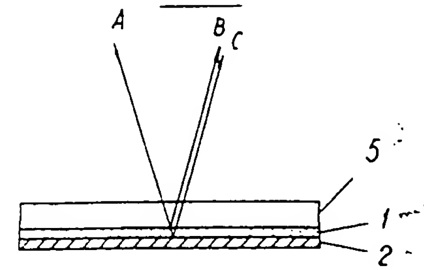
PURPOSE: To improve the S/N ratio of a reproduced signal by laminating the 1st and the 2nd magnetic film layer which differ in refractive index on a transparent substrate and utilizing Fraday effect and Kerr effect in combination.

CONSTITUTION: On the transparent substrate 5, the 1st magnetic layer 1 and the 2nd magnetic layer 2 are laminated. Both magnetic layers consists of vertically magnetized films which differ in refractive index sufficiently and reproducing light is reflected by the interface between the magnetic layers 1 and 2. The repoducing light A entered from the substrate side 5 is reflected partially by the surface of the 1st magnetic layer 1 and its reflected light B has the plane of polarization rotated by Kerr effect. The transmitted light has the plane of polarization rotated by Faraday effect, and also has the plane of polarization rotated by Kerr effect when reflected by the interface with the magnetic film 2 and the plane of the polarization rotated again by Faraday effect when transmitted through the magnetic film 1 to obtain reflected light ~~C. The directions~~ of rotations bt Faraday effect and Kerr effect are made coincide with each other. Consequently, the reflected light B and reflected light C become to be arithmetically, thereby improving the S/N ratio of reproduction.



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⑭光磁気記録媒体

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明　細　書

1、発明の名称

光磁気記録媒体

2、特許請求の範囲

(1) 屈折率が異なる第1磁性膜層及び第2磁性膜層からなる多層構造の記録層を透明基板上に設けてなる光磁気記録媒体。

(2) 第1磁性膜層及び第2磁性膜層からなる多層構造の記録層は、再生光入射側に位置する第1磁性層のカー回転方向と当該第1磁性層のファラデー回転方向及び第2磁性層のカー回転方向が再生光の波長に対して全て一致する2層の垂直磁化膜からなり、前記第1磁性層は再生光の往復に対し十分な透過が得られる膜厚を有し、前記第2磁性層は直接もしくは再生光に対して透明で第2磁性層と屈折率の異なる薄膜物質を介して上記第1磁性層に接するように構成したことを特徴とする特許請求の範囲第1項記載の光磁気記録媒体。

3、発明の詳細な説明

本発明はレーザー光の熱を利用して記録を行ない、磁気光学効果を利用して再生を行なう光磁気記録媒体に関するものである。

一般に、光磁気記録媒体は基板上に磁性薄膜を設けたものであり、光磁気記録媒体の再生方式には、ファラデー効果を利用するものと、カー効果を利用するものがある。しかしながら、ファラデー効果を利用するものは光の透過による偏光面の回転から磁化方向を検出するもので、光源と検出器が記録媒体に対して相対する位置にあるため、記録媒体の片面しか利用できないだけでなく、光学的経路が長くなり装置として大型になる欠点があった。一方、カー効果を利用するものは光の反射による偏光面の回転方向を検出するもので、光源及び検出器が記録媒体に対して同じ側に位置するため、記録媒体の両面に記録できる他、光学的経路が短かくなり装置を小型にできるが、カー効果による信号は微弱であり、信号検出が困難であるという欠点があった。さらに記録媒体の裏面に金属反射膜を設けてファラデー効果を用いる方式

も考えられているが、未だ再生SN比の充分なものが得られていない。

本発明はこのような従来の欠点を解消するものであり、磁性薄膜の多層構造を有する反射型の光磁気記録媒体としたものである。かかる構成によれば、反射型再生方式の利点を生かし、かつ高い再生SN比を得ることができる利点を有するものである。

再生のSN比はショット雑音が支配的な場合は

$$S/N \propto \sqrt{I_0}\cdot\theta$$

増幅器雑音が支配的な場合は

$$S/N \propto I_0\cdot\theta$$

となる。ここでI_0は検出器に到達する再生光パワー、θは記録媒体による再生光の偏光面の回転角である。よって再生SN比の向上のためには、再生光の偏光面の回転角と検出器に到達する再生光パワーの増加が重要である。本発明では、磁性薄膜よりなる記録層を多層構造にすることによって、記録媒体での反射による再生光の偏光面の回転(カー効果)と透過による偏光面の回転(ファラデー効果)を効果的に組み合せ、再生光の偏光面の回転角および検出器に到達する再生光パワーを増加させて再生SN比の向上を計ることができるものである。

以下、本発明の光磁気記録媒体について実施例の図面と共に説明する。

第1図は本発明の一実施例を示しており、第1図において、1は第1磁性層、2は第2磁性層であり、これら第1，第2の磁性層1，2は積層構造をなし、透明基板5上に設けられている。上記2つの磁性層1，2はその屈折率が充分に異なる垂直磁化膜で構成されており、この場合、上記2つの磁性層1，2の界面で再生光が充分に反射される。このような構成にすると、基板5側から入射した再生光Aは第1磁性層1の表面で一部反射され、その反射光Bはカー効果で偏光面が回転している。透過光はファラデー効果で偏光面が回転して第2磁性層2との界面に達し、第2磁性層2の表面で反射され、その反射時にカー効果によって偏光面がさらに回転する。そして、第2磁性層2の表面で反射された反射光Cは第1磁性層1を折り返し透過するためファラデー効果によって偏光面がさらに回転して第1磁性層外に出る。よって、第1磁性層1の表面での反射光Bと2つの磁性層1，2の界面で反射し第1磁性層1を透過して来た光Cの和が検出されることになる。ここで第1磁性層1のカー回転角方向およびファラデー回転角方向と第2磁性層2のカー回転角方向は一致するように選んであるので、2つの光路を通った再生光の偏光面の回転角および検出器に到達する再生光パワーは相加的になり、再生SN比が向上することになる。

第2図は本発明の他の実施例を示しており、第2図において、3は第1磁性層、4は第2磁性層であり、これら第1，第2の磁性層3，4は積層構造をなし、透明電極5上に設けられている。上記2つの磁性層3，4はその屈折率の差が小さい垂直磁化膜で構成されている。この場合、第2の磁性層4の表面での反射光が減少するので、2つの磁性層3，4の間に再生光Aに対して透明で第2磁性層4と屈折率の充分に異なる薄膜物質6を設け、第2磁性層4の表面での反射光Cを増加させて効果を高めている。このような構成にすると、基板5側から入射した再生光Aは第1磁性層3の表面で一部反射され、その反射光Bはカー効果で偏光面が回転している。透過光はファラデー効果で偏光面が回転して薄膜物質の層6を介して第2磁性層4との界面に達し、第2磁性層4の表面で反射され、その反射時にカー効果によって偏光面がさらに回転する。そして、第2磁性層4の表面で反射された反射光Cは第1磁性層3を折り返し透過するためファラデー効果によって偏光面がさらに回転して第1磁性層3の外に出る。よって、第1磁性層3の表面での反射光Bと2つの磁性層3，4の界面で反射し第1磁性層3を透過して来た光Cの和が検出されることになる。ここで第1磁性層3のカー回転角方向及びファラデー回転角方向と第2磁性層4のカー回転角方向は一致するように選んであるので、2つの光路を通った再生光の偏光面の回転角および検出器に到達する再生

光パワーは相加的になり、再生ＳＮ比が向上することになる。

具体的には透明基板５としてガラスを用い、その上に第１磁性層３としてGd Tb Feをスパッタによって厚さ２５０Åに設け、透明薄膜物質６としてSiO_2を厚さ１００Åに蒸着し、さらにその上に第２磁性層４としてGd Tb Feをスパッタによって厚さ３００Å設けた構造の光磁気記録媒体について再生ＳＮ比を測定した結果、単一記録磁性層の媒体に比較して約６dB改善が得られた。

以上、詳述したように本発明によれば、記録磁性層を２層にして各層によるカー効果、ファラデー効果を有効に組み合せることによって、従来の単一記録磁性層の光磁気記録媒体の再生ＳＮ比を大きく改善できる利点を有するものである。

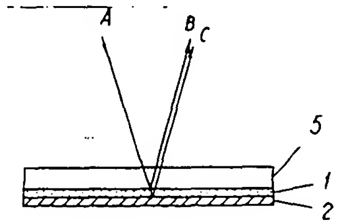
４、図面の簡単な説明

第１図は本発明の一実施例を示す光磁気記録媒体の断面図、第２図は本発明の他の実施例を示す光磁気記録媒体の断面図である。

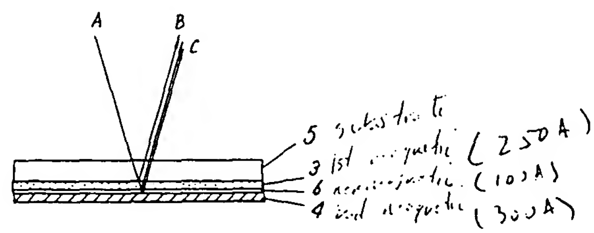
１，３……第１磁性層、２，４……第２磁性層、５……透明基板、６……透明薄膜物質。

代理人の氏名　弁理士　中　尾　敏　男　ほか１名

第　1　図



第　2　図



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(71) Applicant: Matsushita Denki KK

(54) Photomagnetic recording medium

1. Title of invention: /223*

Photomagnetic recording medium

2. Claim:

(1) A photomagnetic recording medium which is produced by placing a laminated recording layer (consisting of the first magnetic film layer and the second magnetic film layer having different refractive indices) on a transparent substrate.

(2) A photomagnetic recording medium, described in Claim 1, in which the laminated recording layer (made of the first magnetic film layer and the second magnetic film layer) consists of two vertically magnetized films which satisfy the following: the direction of rotation (of the plane of polarization) by the Kerr effect in the first magnetic layer (located on the side where the reproducing light enters), the direction of rotation by the Faraday effect in the same layer, and the direction of rotation by the Kerr effect in the second magnetic layer all coincide with each other in relation to the wavelength of the reproducing light; the first magnetic layer has an appropriate thickness for sufficient transmission of the reproducing light in both directions; and the second magnetic layer is put in contact with the first magnetic layer directly or with a thin-film substance (which is transparent to the reproducing light and has a refractive index different from that of the second magnetic layer) in between.

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* Numbers in the margin indicate pagination in the foreign text.

3. Detailed explanation of the invention:

[Industrial field]

This invention pertains to a photomagnetic recording medium which uses the heat from laser beams for recording and uses the magneto-optical effect for reproduction.

Normally, a photomagnetic recording medium is made by forming a thin magnetic film on a substrate. Some photomagnetic recording media use the Faraday effect for their reproduction method, whereas others use the Kerr effect. A medium using the Faraday effect detects the direction of magnetization using the rotation of polarization plane by light transmission. Since the light source and the detector are arranged to face each other, only one side of the recording medium can be used. Also, this tends to lengthen the optical path and make the device large-sized. On the other hand, a medium using the Kerr effect detects the direction of the rotation of the polarization plane using light reflection. Since light source and the detector are placed on the same side of the recording medium, the recording can be performed on both sides of the recording medium. Also, the optical path can be shortened, which makes the device compact. However, the Kerr effect produces weak signals which are difficult to detect. A proposal has been made to place a metal reflector film on the back side of the recording medium for utilizing the Faraday effect. However, no such /224 medium has been obtained with a satisfactory S/N ratio in the reproduction.

This invention (which solves the conventional problem) is a reflection-type photomagnetic recording medium having a multi-layer

structure of thin magnetic films. This structure provides a high S/N ratio in the reproduction based on the advantage of the reflection-type method of reproduction.

When the noises are predominantly shot noises, the S/N ratio in the reproduction will be:

$$S/N \propto \sqrt{I_0} \cdot \theta$$

When the noises are predominantly amplifying noises, the S/N ratio in the reproduction will be:

$$S/N \propto I_0 \cdot \theta$$

Here, I_0 is the power of the reproducing light which reaches the detector; and θ is the angle in which the polarization plane of the reproducing light is rotated by the recording medium. In order to improve the S/N ratio, it is necessary to increase the rotation angle of the polarization plane of the reproducing light and the pow~~d~~er of the reproducing light which reaches the detector. In this invention, the recording layer (made of thin magnetic films) consists of multiple layers in order to effectively combine the rotation of the polarization plane of the reproducing light by reflection (the Kerr effect) and the rotation of the polarization plane of the reproducing light by transmission (the Faraday effect). Therefore, it is possible to increase the rotation angle of the polarization plane of the reproducing light and the powder of the reproducing light which reaches the detector; and the S/N ratio in the reproduction can be improved.

The invented photomagnetic recording medium will be explained below using the figures showing some practical examples.

Figure 1 shows a practical example of this invention. In this figure, Item 1 is the first magnetic layer; and Item 2 is the second magnetic layer. The first and second magnetic layers 1, 2 are laminated together and placed on a transparent substrate 5. The first and second magnetic layers 1, 2 are vertically magnetized films with their refractive indices differing from each other. In this case, a reproducing light is reflected sufficiently at the interface between the two magnetic layers 1, 2. In this construction, the reproducing light A enters from the side of the substrate 5, and is partially reflected on the surface of the first magnetic layer 1. The reflected light B has its polarization plane rotated by the Kerr effect. The transmitted light has its polarization plane rotated by the Faraday effect, reaches the interface with the second magnetic layer 2, and is reflected on the surface of the second magnetic layer 2. At the time of the reflection, the polarization plane is rotated by the Kerr effect. The reflected light C (reflected on the surface of the second magnetic layer 2) is transmitted through the first magnetic layer 1 in the reverse direction, and has its polarization plane rotated by the Faraday effect when the light exits the first magnetic layer. Therefore, the detector detects a combination of the reflected light B (reflected on the surface of the first magnetic layer 1) and the reflected light C (reflected at the interface between the two magnetic layers 1, 2 and transmitted through the first magnetic layer 1). The direction of rotation by the Kerr effect and the direction of rotation by the Faraday effect in the first magnetic layer 1 and the direction of rotation by the Kerr effect in the second magnetic layer 2 are all set to coincide with each other.

Therefore, the rotation angles of the polarization plane of the reproducing lights (which passed two different optical paths) are combined together, and so are the powder of the reproducing lights which reach the detector. This improves the S/N ratio in the reproduction.

Figure 2 shows another practical example of this invention. In this figure, Item 3 is the first magnetic layer; and Item 4 is the second magnetic layer. The first and second magnetic layers 3, 4 are laminated together and placed on a transparent substrate 5. The first and second magnetic layers 3, 4 are vertically magnetized films with their refractive indices differing only slightly from each other. In this case, the reflected light on the surface of the second magnetic layer 4 will be reduced. Therefore, a thin-film substance 6 (which is transparent to the reproducing light A and has a refractive index sufficiently different from that of the second magnetic layer 4) is placed between the two magnetic layers 3, 4 in order to increase the reflected light C from the surface of the second layer 4 for higher effect. In this construction, the reproducing light A enters from the side of the substrate 5, and is partially reflected on the surface of the first magnetic layer 3. The reflected light B has its polarization plane rotated by the Kerr effect. The transmitted light has its polarization plane rotated by the Faraday effect, reaches the interface with the second magnetic layer 4 via the thin-film substance 6, and is reflected on the surface of the second magnetic layer 4. At the time of the reflection, the polarization plane is rotated by the Kerr effect. The reflected light C (reflected on the surface of the second magnetic layer 4) is transmitted through the first magnetic layer 3 in the

reverse direction, and has its polarization plane rotated by the Faraday effect when the light exits the first magnetic layer 3. Therefore, the detector detects a combination of the reflected light B (reflected on the surface of the first magnetic layer 3) and the reflected light C (reflected at the interface between the two magnetic layers 3, 4 and transmitted through the first magnetic layer 3). The direction of rotation by the Kerr effect and the direction of rotation by the Faraday effect in the first magnetic layer 3 and the direction of rotation by the Kerr effect in the second magnetic layer 4 are all set to coincide with each other. Therefore, the rotation angles of the polarization plane of the reproducing lights (which passed two different optical paths) are combined together, and so are the powder of the reproducing lights which reach the detector. This improves the S/N ratio in the /225
reproduction.

In an actual example, the transparent substrate 5 was made of glass; GdTbFe was used to form the first magnetic layer 3 (with the thickness of 250Å) over the substrate by sputtering; SiO_2 was used to form the transparent thin-film substance 6 (with the thickness of 100Å) by vapor deposition; and GdTbFe was used to form the second magnetic layer 4 (with the thickness of 300Å) over the above layers by sputtering. When we measured the S/N ratio of this photomagnetic recording medium, we found that it was about 6dB higher than the S/N ratio of a medium with a single magnetic recording layer.

As described above in detail, the invented recording medium has two magnetic recording layers in order to combine the Kerr effect and Faraday effect in both layers. Therefore, the S/N ratio in the

reproduction can be improved significantly from the level of a conventional medium with a single magnetic recording layer.

4. Brief explanation of the figures:

Figure 1 is a cross-sectional view of a photomagnetic recording medium which is a practical example of this invention; Figure 2 is a cross-sectional view of a photomagnetic recording medium which is another practical example of this invention.

1, 3... First magnetic layer; 2, 4... Second magnetic layer; 5... Transparent substrate; 6... Transparent thin-film substance.

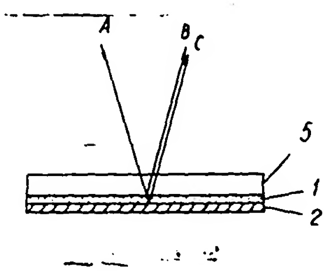

Figure 1

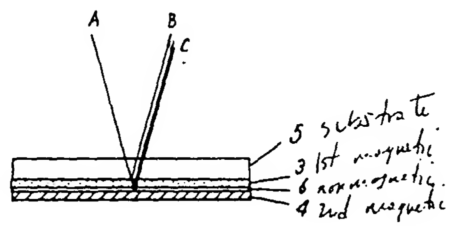

Figure 3